

Urology

KEYWORDS:

Emphysematous Pyelonephritis,
Renal Drainage Percutaneous,
Pyelonephritis.

MANAGEMENT OF EMPHYSEMATOUS
PYELONEPHRITIS WITH CONSERVATIVE AND
MINIMAL INVASIVE DRAINAGE— A CASE SERIES



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ABSTRACT

INTRODUCTION: Emphysematous Pyelonephritis (EPN) is a urologic emergency with acute necrotizing infection with presence of gas in the renal or peri-renal space or in urinary collecting system.

OBJECTIVES: To compare the management of EPN by A] IV Antibiotics only, B] Image guided minimal invasive drainage and IV Antibiotics, C] Open Drainage and D] Emergency Nephrectomy if any.

MATERIALS AND METHODS: This is a retrospective observational study, from July 2019 to March 2022 with 24 patients of EPN admitted in IPD at our institution.

RESULTS: Patients classified according to CT Severity Scale (class1, 2 3A, 3B, 4). Only 12.5% patient had been cured by only medical treatment (one of class1 and other 2 of class 2), 6 (who had stone disease with HDN) out of 24 patients were treated successfully with DJ Stenting and antibiotics and another 3 patients required both DJ Stenting and pigtail drainage. 50% patients were treated with Percutaneous Nephrostomy (PCN) and IV antibiotics. 3 patients among these twelve required pigtail drainage with PCN. 3 patients required open drainage. There was no mortality.

CONCLUSION: It is vital to initiate proper management after a prompt CT scan. Prompt Anti – microbial therapy with minimal-invasive drainage by Pigtail, PCN or D J Stenting not only avoids morbidity, but also saves the kidney.

INTRODUCTION:

Emphysematous Pyelonephritis (EPN) is an urologic emergency characterized by acute necrotizing infection with presence of gas in the renal or peri-renal space or in urinary collecting system. It mainly occurs in diabetic patients, slightly more in female with or without distal obstruction and may precipitate life threatening sepsis.[4,5] Clinical symptoms and signs are often similar to those uncomplicated Pyelonephritis e. g. fever, flank pain, nausea and vomiting. It is mainly associated with diabetes, urolithiasis, obstructive uropathy and chronic kidney disease. Mortality rate is between 20% to 80%. [1] Mostly aggressive approach is taken. [2] But, a good outcome with conservative and image guided minimal invasive approach can be achieved.

OBJECTIVES:

To analyse the basic demography of patients and co- morbidities

associated with EPN. To analyze the outcomes of different methods of management of EPN by A] IV Antibiotics only, B] Image guided minimal invasive drainage and IV Antibiotics and C] Open Drainage and D] Emergency Nephrectomy if any. EPN is categorized by CT severity index in 4 categories [Huang and Tseng EPN Classification]. Study shows results of renal drainage (internal or external drainage along with pigtail, if needed) in each category.

MATERIALS AND METHODS:

This is a retrospective observational study extending from July 2019 to March 2022 assessing 24 patients of EPN admitted in Urology and Medicine indoor in RG KAR Medical College and Hospital. All patients were admitted with clinical features of sepsis and EPN was confirmed in imaging studies (USG OF KIDNEY f/b NCCT KUB which shows gas in renal parenchyma or in peri –renal tissue or in collecting system with or without collection of fluid/ pus.) This study includes 24 patients admitted in indoor with clinical features of sepsis and diagnosed as EPN in CT Abdomen with/ without contrast depending on renal function. The following factors were analyzed in studies: demography, symptoms, duration of disease, co morbidities with duration, serum Creatinine, clinical features of shock. Investigations were done as : complete blood count, serum urea and Creatinine, urine analysis and culture, serum electrolytes, blood sugar level and imaging studies (USG KUB and CT scan of KUB with CT severity grading) showing any calculi or obstruction, perinephric or paranephric abscess and presence of gas in renal parenchyma or pelvi-calyceal system. Treatment methods as: medical or surgical treatment, IV antibiotics, duration of admission, internal or external drainage, open drainage, subsequent management of renal calculi and emergency nephrectomy were also analyzed. A few patients responded to IV antibiotics and conservative Mx, whereas others responded to either internal drainage (DJ Stenting) or external drainage (per cutaneous Nephrostomy/ PCN) or both. None of these cases required nephrectomy. EPN grade was done as per Haung et al.

RESULTS:

Patients were classified according to CT Severity Scale (class1, 2, 3A, 3B, 4) of Huang and Tseng. In this study 12.5% patient had been cured by only medical treatment (one of class1 and other 2 of class 2), 9 (among whom 6 had stone disease with HDN) out of 24 patients were treated successfully with D J Stenting and antibiotics and 3 patients required both D J Stenting and PCN drainage in whom only stenting is not adequate to relieve clinical symptoms. 50% patients were treated with Percutaneous Nephrostomy (PCN) and IV antibiotics. 3 patients among these 12 required second external

drainage of pus from cavity of peri -renal tissue along with PCN. 3 patients required open drainage, who failed to respond to minimal invasive drainage due to organized pus and multi loculated cavity. There was no mortality and no emergency nephrectomy in this group.

In this study, the mean age was 56 years with male to female ratio of 1:3 (6:18). The median duration of symptoms was 20 days (average 11–75 days). Fever and flank pain were seen in 83.33% (20 out of 24) of patients, vomiting in 16 (66.66%) of patients, and hematuria in 25% (6) of patients. Eighty percent (20 out of 24) of patients had tachycardia, 40% (10 out of 24) of patients had hypotension (defined as systolic blood pressure <90 mmHg), 50% (12 out of 24) renal angle tenderness.

Most of the patients (20 out of 24; 80%) were in the age group of 50–70 years. Ninety percent (22 out of 24) of patients were diabetic, 72% (16 out of 22) of whom were females. All 6 male patients were diabetic. Fifty percent (12 out of 24) of patients were hypertensive with coronary artery disease.

70 percent of patients had left sided involvement. There was one patient with bilateral renal involvement and one patient with single kidney. Imaging demonstrated renal calculi in 40% (10 out of 24) of patients and pararenal or perinephric abscess in 25% (6 out of 24) of patients. As per Huang and Tseng classification, 28% (7 out of 24) of patients were categorized as Class 2 EPN and 50% (12 out of 24) of patients as class 3 EPN. 8% of patients were categorized as class 4 EPN [Table 1].

Urine culture was sterile in 30% of the participants. *E. coli* was isolated from the urine samples of 50% of patients and Klebsiella in 10% Proteus species in the remaining 10%. Meropenem was sensitive in all the cases, followed by Levofloxacin in 50% of patients. All the patients in the study were started on IV Antibiotics. In addition, correction of hydration and respiratory status with dyselectrolytemia was given priority.

At presentation, 8 patients had eGFR <60 ml/min/1.73 m2. Dyselectrolytemia was seen in 50% (12 out of 24) of patients. All the 22 diabetic patients had a random blood sugar level of more than 200 mg/dl at presentation. Eighty percent of patients were anemic (hemoglobin level in males <12 g/dl and females <11 g/dl). Leukocytosis (total leukocyte count >11000 cmm) was present in 90% of the patients.

Thirty minimally invasive and three open procedures were done in 24 patients. DJ stenting was carried out as the primary minimally invasive measure in 50% of patients (Class 3B EPN – 3, Class 3A EPN – 2, and Class 2 EPN – 5 and Class 1 EPN 2 cases). PCN was carried out as minimally invasive measure in 50% of patients (Class 3A EPN -2, Class 3B EPN -8, Class 4 EPN -2). Those belonging to Class 2 EPN and Class 3A EPN needed no further intervention.

In addition to these procedures, among patients of Class 3B EPN and Class 4 EPN, three underwent percutaneous external drainage of pus from perinephric abscess and three patients had been gone through open surgical drainage (1 from Class 3B and 2 from Class 4). Total 3 patients had to undergo PCN in addition to previously placed DJ stent and 3 patients had both PCN and external drainage. 2 cases of Class 4 EPN and 1 case of Class 3B EPN needed open surgical drainage due to thick and loculated paranephric collection despite of PCN insertion, as symptoms did not improve after PCN.

None of the patients had to undergo an emergent nephrectomy. Urine culture was repeated 5 days after initiation of treatment, and the patients were advised oral antibiotics according to the culture sensitivity report on discharge.

The median duration of hospital stay was 14 days (range: 11–40 days). All the patients were managed in general ward. The median

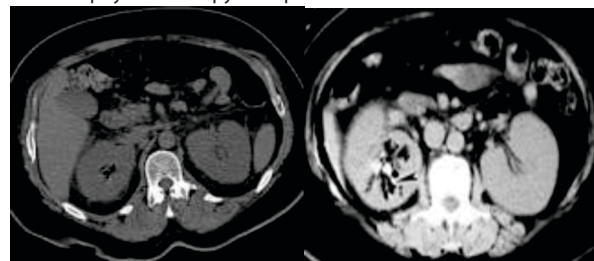
duration of stay for males was 19.5 days and for females was 12.5 days. Median duration of hospital stay for Class 2 EPN was 6.5 days, for Class 3A EPN was 14 days, and for class 3B EPN was 20.5 days. There was no mortality in this group. The patients were followed up to 6 months after discharge. Patients were asked to repeat USG, renal function tests, and urine culture after 4 weeks.

All the patients remained symptom free during the follow-up period. Out of ten patients with renal calculi, 6 patients underwent percutaneous nephrolithotomy, 3 underwent URSL and 1 patient underwent Open Pyelolithotomy after 3 months. Four patients (Class 3B) underwent elective open simple nephrectomy after 3 months for non functional kidney and refractory flank pain. They were diabetic and belonged to Class 3B EPN.

Table 1: Computed Tomography Severity Grading Of Emphysematous Pyelonephritis As Proposed By Huang And Tseng (n=24)

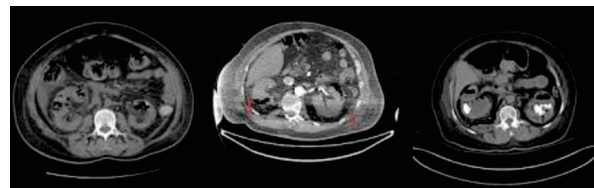
CLASS OF EPN*	GRADE DESCRIPTION	MALES (n %)	FEMALE (n %)	TOTAL (%)
I	Gas confined to collecting system	0	3(12.5%)	3(12.5%)
II	Gas confined to renal parenchyma alone	3(12.5%)	4(16.66%)	7(29.16%)
IIIA	Perinephric extension of gas or abscess	0	3(12.5%)	3(12.5%)
IIIB	Extension of gas beyond Gerota fascia	3(12.5%)	6(25%)	9(37.5%)
IV	Bilateral EPN or EPN in solitary kidney		2(8.33%)	2(8.33%)

*EPN: Emphysematous pyelonephritis



Class I EPN

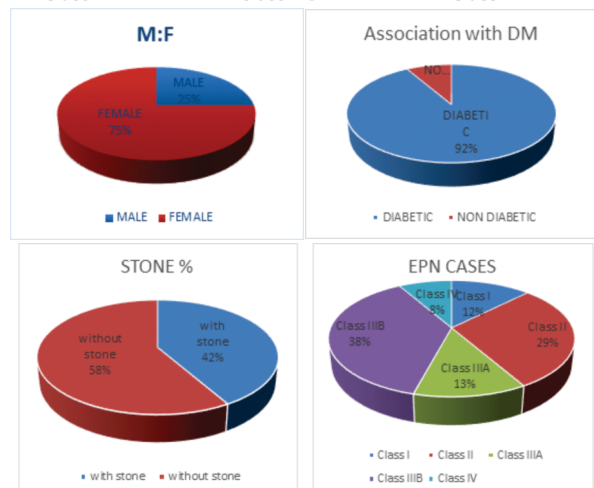
Class II EPN



Class IIIA EPN

Class IIIB EPN

Class IV EPN



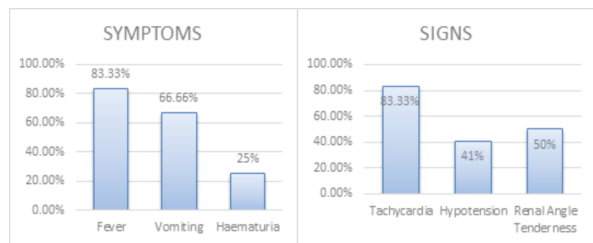
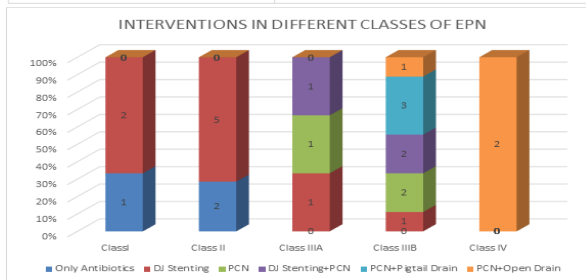
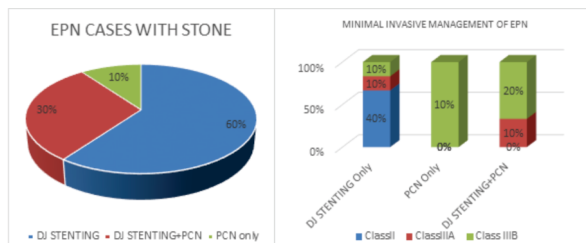
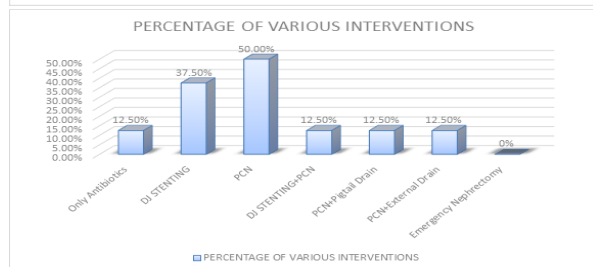
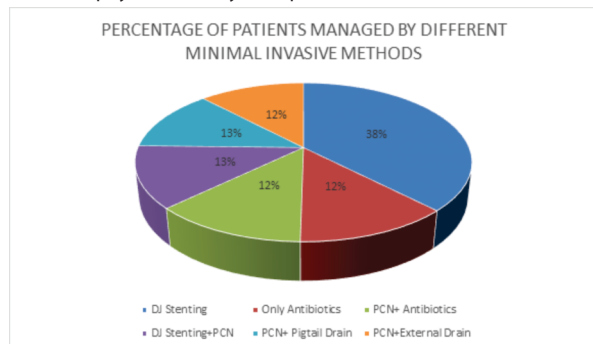


Table 2: Management Of The Patients In The Study Group:

Initial Treatment	Subsequent Management	Additional Procedure	EPN CLASS	TOTAL	n (%)
Antibiotics	None	None	Class I - 1 case Class II - 2case	3 cases	12.5
Antibiotics	INTERNAL DRAINAGE: DJ STENTING	None	Class I - 2case Class II - 5case Class IIIA- 1case Class IIIB- 1case	9 cases	37.5
Antibiotics	INTERNAL DRAINAGE: DJ STENTING	EXTERNAL DRAINAGE: PERCUTANEO US NEPHROSTOMY (PCN)	Class IIIA- 1case Class IIIB- 2case	3 cases	12.5
Antibiotics	PERCUTANEO US NEPHROSTOMY (PCN)		Class IIIA- 1case Class IIIB- 2case	3 cases	12.5
Antibiotics	PERCUTANEO US NEPHROSTOMY (PCN)	PIGTAIL DRAINAGE OF ABCESS CAVITY	Class IIIB- 3case	3 cases	12.5
Antibiotics	PERCUTANEO US NEPHROSTOMY (PCN)	OPEN DRAINAGE*	Class IIIB- 1case Class IV- 2case	3 case	12.5

*Patient failed to respond to percutaneous drainage alone with repeat USG showing persistent perinephric/ paranephric collection. Emergent management undertaken in the study group. DJ: Double J, EPN: Emphysematous Pyelonephritis.



DISCUSSION:

EPN is an urologic emergency associated with acute necrotizing parenchymal and perinephric infection. In 1962, Schultz and Klorfein coined the term Emphysematous Pyelonephritis.[9]

E. coli (82%) and *Klebsiella* species (12%) are the most common organisms.[10] We isolated *E. coli* in 50% of our patients. Other organisms responsible are *Pseudomonas aeruginosa*, bactericides, *Aerobacter aerogenes*, *Proteus mirabilis*, *Cryptococcus neoformans*, *Klebsiella pneumonia*, *Aspergillus fumigatus*, *Clostridium septicum*. The exact pathogenesis is poorly understood. EPN is common in patients with uncontrolled diabetes with high level of glycosylated hemoglobin, renal stones, renal failure, immunosuppression, obstructed upper tract and polycystic kidney disease. The mechanism for gas production in EPN is not yet well understood. One theory is that, in uncontrolled diabetes, glucose fermentation by the offending organism provides an excellent microenvironment for the organism's growth and rapid catabolism, leading to the massive production of carbon dioxide and hydrogen.[4,5] Because of impaired gaseous transport, carbon dioxide and hydrogen accumulate in tissues, leading to tissue infarction and, thus, to further damage to the renal parenchyma. In cases of unrelieved urinary tract obstruction, urinary stasis leads to severe infection, and increased intra-pelvic pressure compromises and impairs the renal circulation, resulting in poor tissue perfusion, which makes antibacterial therapy ineffective.

In our study ninety percent patients were diabetic, as seen in a study of Aswathaman *et al.*[12], and by Karthikeyan *et al.*, DM was seen in 84.8%.[11], and in a study of Soumish Sengupta *et al.*[3]. Ratio of male:female in our study was 1:3. In a similar study by Karthikeyan *et al.*, male:female ratio was 1:1.4.[11]

Urinary tract obstruction has been reported to cause EPN in Urinary tract obstruction has been reported to cause EPN in 25%–40% of patients.[13]. In our study, 41.6% of the patients had renal calculi with obstructed system.

In a recent study, medical management alone resulted in 50% mortality. Twenty-five cases underwent medical management with subsequent emergency nephrectomy, 13.5% were treated with medical management and percutaneous drainage, and 6.6% cases were managed with antibiotics and elective nephrectomy.[14] In our study, medical management with antibiotics was effective in 12.5% of patients. 37.5% of patients were treated with medical management and internal drainage or DJ stenting. 12.5% of the patients were treated with medical management and PCN. 12.5% needed PCN drainage in addition to DJ stenting. 12.5% needed percutaneous drainage of perinephric abscess along with PCN. 12.5% of patients were treated with open drainage in addition to

PCN drainage of perinephric collection as they failed to respond to minimally invasive intervention alone due to deteriorating symptoms and persistent collections. Total 50% patient in our study needed external drainage as primary or as an additional procedure for proper management of EPN.

Some authors reported that Percutaneous drainage under USG was not suitable for patients with gas-producing infection, because the significant distal shadowing and reverberation artifact produced by ultrasound made it difficult to determine the exact placement of the drainage catheter. But, in many studies ultrasound not only clearly demonstrates the gas and fluid collection, but is also useful in guiding placement of the percutaneous drainage catheter.[26]

There is no mortality in our study. Karthikeyan *et al.* in a similar study noted mortality of 3% only.[11] Conservative treatment was identified to have an odds ratio of 2.85 for mortality.[15] In our study, the median delay in presentation to our center was 10 days. In a similar study by Aswathaman *et al.*, delay in presentation beyond 15 days contributed to 80% mortality.[11] With the integration of advanced imaging technology and interventional radiology, correction of fluid, and electrolyte balance, and antimicrobial therapy better outcome has been observed.

In a previous study, third-generation cephalosporins were recommended as the initial drug in their patients with EPN and carbapenem in patients with prior hospitalization or antibiotic use.[16] In this study, patients were mainly treated with IV carbapenem and fluoroquinolones. The success of conservative management has been reported in small case series and few case reports.[17-21]

There were some limitations of this study. First, it is a retrospective study. Second, this study was conducted on a small patient population. The drawback of the conservative and minimally invasive management of EPN was overall increased hospital stay and treatment cost. They needed admission again after 3 months of their acute episodes for treatment of their underlying surgical pathology such as PCNL, URSL, open pyelolithotomy and also simple nephrectomy in 4 cases for nonfunctioning kidney with refractory urinary tract infection and flank pain.

In a recent study by Somani, Thorpe and Cook et. al.	In our study population
13.5% patient managed with PCN and medical management	50% patient managed with PCN and medical management
No internal drainage or DJ Stenting done	38% patients (Class I and Class II) were managed with DJ stenting and IV antibiotics
25% needed emergency nephrectomy after prior medical management	No emergency nephrectomy was needed in our study population
No Drainage Procedure done	12.5% needed multiple percutaneous image guided drainage and 12.5% needed open surgical drainage
Mortality 50% alone with medical management	12.5% managed with medical management (Class I and Class II), No Mortality
6.6% cases needed elective nephrectomy after medical management	16.66% cases needed elective nephrectomy on a later date

CONCLUSION:

Most cases are associated with uncontrolled diabetes mellitus. There have been case of EPN non-diabetic patients with ureteral obstruction. CT scan is the most useful modality for diagnosing EPN and guiding Percutaneous renal drainage. Ultrasound-guided percutaneous renal drainage has been effectively used in treating our patients. Prompt Anti – microbial therapy with early drainage by Pigtail, PCN or DJ Stenting not only avoids morbidity, but also saves the kidney. No emergency nephrectomy was done in this series and

in this series there is no mortality. In this case series, only 4 patients had later undergone Simple Nephrectomy due to non functioning kidney and persistent pain after successful management of acute episode of EPN.

It is essential to initiate the management with a prompt CT imaging. Proactive hemodynamic stabilization, antimicrobial therapy, complementing it with internal or external drainage of system or any collection or combined drainage (if needed) in cases not responding to antibiotics alone can treat most of the patients with this pathology. Therefore, early, adequate drainage (internal or external), combined with broad-spectrum antibacterial therapy is not only life-saving, but also a kidney salvage procedure. If prompt resolution of the gas collection or clinical improvement does not occur within 48 hours, open drainage must be done immediately.

CONFLICT OF INTEREST: There is no conflict of interest in the study.

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